FORM PTO-1390
REV. 5-93

US DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEYS DOCKET NUMBER
P01,0073

U.S.APPLICATION NO. (if known, see 37 CFR 1.5)
09/807126

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE99/03170	**01 October 1999**	**15 October 1998**

TITLE OF INVENTION
ANTENNA ARRAY FOR A RADIO STATION WHICH CAN BE OPERATED IN A PLURALITY OF FREQUENCY RANGES, AND A RADIO STATION

APPLICANT(S) FOR DO/EO/US
Rainer ECKERT

Applicant herewith submits to the United States /Designated/Elected Office (DO/EO/US) the following items and other information.

1. ■ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. □ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ■ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay.
4. ■ A proper Demand for International Preliminary Examination will be made by the 19th month from the earliest claimed priority date.

5. ■ A copy of International Application as filed (35 U.S.C. 371(c)(2))
   a. ■ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. □ has been transmitted by the International Bureau.
   c. □ is not required, as the application was filed in the United States Receiving Office (RO/US)
6. ■ A translation of the International Application into English (35 U.S.C. 371(c)(2).

7. ■ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. §371(c)(3))
   a. □ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. □ have been transmitted by the International Bureau.
   c. □ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ■ have not been made and will not be made.

8. □ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. ■ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). **Executed**

10. ■ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ■ An Information Disclosure Statement under 37 C.F.R. 1.97 and 1.98; **(PTO 1449, Prior Art, Search Report)**.

12. ■ An assignment document for recording. A separate cover sheet in compliance with 37 C.F.R. 3 28 and 3.31 is included.
(SEE ATTACHED ENVELOPE)

13. ■ A FIRST preliminary amendment.
    □ A SECOND or SUBSEQUENT preliminary amendment.

14. ■ A substitute specification **- Marked up copy of Substitute Specification.**

15. □ A change of power of attorney and/or address letter.

16. ■ Other items or information:
    a. ■ Submission of Drawings **- Eight sheets of drawings - Drawing Correction Letter - Translation of Drawings**

    b. ■ **EXPRESS MAIL #EL655302205US dated April 6, 2001**

U.S. APPLICATION NO. (if known, see 37 C.F.R. 1.5)	*INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/807126	PCT/DE99/03170	P01,0073

JC08 Rec'd PCT/PTO 06 APR 2001

BASIC NATIONAL FEE (37 C.F.R. 1.492(a)(1)-(5):

Search Report has been prepared by the EPO or JPO	$860.00
International preliminary examination fee paid to USPTO (37 C.F.R. 1.482)	$690.00
No international preliminary examination fee paid to USPTO (37 C.F.R. 1.482) but international search fee paid to USPTO (37 C.F.R. 1.445(a)(2)	$760.00
Neither international preliminary examination fee (37 C.F.R. 1.482) nor international search fee (37 C.F.R. 1.445(a)(2) paid to USPTO	$970.00
International preliminary examination fee paid to USPTO (37 C.F.R. 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4)	$ 96.00

ENTER APPROPRIATE BASIC FEE AMOUNT =				$860.00	
Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 C.F.R. 1.492(e)).				$ 0	
Claims	Number Filed		Number Extra	Rate	
Total Claims	7	- 20 =	0	X $ 18.00	$ 0
Independent Claims	3	- 3 =	0	X $ 80.00	$ 0
Multiple Dependent Claims				$270.00 +	$
TOTAL OF ABOVE CALCULATIONS =					$ 0
Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 C.F.R. 1.9, 1.27, 1.28)					$
SUBTOTAL =					$ 0
Processing fee of $130.00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)). +					$
TOTAL NATIONAL FEE =					$ 0
Fee for recording the enclosed assignment (37 C.F.R. 1.21(h). The assignment must be accompanied by an appropriate cover sheet (37 C.F.R. 3.28, 3.31). $40.00 per property +					
TOTAL FEES ENCLOSED =					$860.00
				Amount to be refunded	$
				charged	$

a. ■ A check in the amount of $ **860.00** to cover the above fees is enclosed.

b. □ Please charge my Deposit Account No. _____ in the amount of $ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ■ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **501519**. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 C.F.R. 1.494 or 1.495 has not been met, a petition to revive (37 C.F.R. 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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SIGNATURE

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BOX PCT

IN THE UNITED STATES ELECTED OFFICE

OF THE UNITED STATES PATENT AND TRADEMARK OFFICE

UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT: Rainer ECKERT

DOCKET NO: P01,0073

SERIAL NO: GROUP ART UNIT:

EXAMINER:

INTERNATIONAL APPLICATION NO: PCT/DE99/03170

INTERNATIONAL FILING DATE: 01 October 1999

INVENTION: **"ANTENNA ARRAY FOR A RADIO STATION WHICH CAN BE OPERATED IN A PLURALITY OF FREQUENCY RANGES, AND A RADIO STATION"**

Assistant Commissioner for Patents,
Washington, D.C. 20231

Sir:

As a Preliminary Amendment for entry into the National Stage for the above-identified PCT application, the following is submitted:

IN THE SPECIFICATION, TITLE AND ABSTRACT:

Enclosed is a Substitute Specification amending the title, specification, and abstract No new matter is added by the substitute specification. A marked-up copy

of the specification, title and abstract is also enclosed.

IN THE DRAWINGS:

Please amend the drawings as indicated in the attached Drawing Correction Letter.

IN THE CLAIMS:

Please cancel claims 1-3 from the substitute pages in the PCT prosecution and add new claims 11-17 as follows:

11. A mobile station for operation within different mobile radio systems to which a different frequency range is in each case allocated, each frequency range in each case having a transmission frequency band and a reception frequency band, comprising:

a first transmission antenna for transmitting signals within the transmission frequency band of a first frequency range;

a second transmission antenna for transmitting signals within the transmission frequency band of a second frequency range;

a first reception antenna for receiving signals within the reception frequency band of the first frequency range; and

a second reception antenna for receiving signals within the reception frequency band of the second frequency range.

12. The mobile station as claimed in claim 11 in which the first transmission antenna is identical to the second transmission antenna.

13. The mobile station as claimed in claim 11 in which the first reception antenna is identical to the second reception antenna.

14. A mobile station for operation within different mobile radio systems to which a different frequency range is in each case allocated, each frequency range in each case having a transmission frequency band and a reception frequency band, comprising:

a first transmission antenna for transmitting signals within the transmission frequency band of a first frequency range;

a second transmission antenna for transmitting signals within the transmission frequency band of a second frequency range;

a first reception antenna for receiving signals within the reception frequency band of the first frequency range;

a second reception antenna for receiving signals within the reception frequency band of the second frequency range;

the first transmission antenna being substantially identical to the second transmission antenna; and

the first reception antenna being substantially identical to the second reception antenna.

15. A method for operating a mobile station within different mobile radio systems to which a different frequency range is in each case allocated, each frequency range in each case having a transmission frequency band and a reception frequency band, comprising the steps of:

transmitting signals within the transmission frequency band of a first frequency range with a first transmission antenna;

transmitting signals within the transmission frequency band of a second frequency range with a second transmission antenna;

receiving signals within the reception frequency band of the first frequency range with a first reception antenna; and

receiving signals within the reception frequency band of the second frequency range with a second reception antenna.

16. The method according to claim 15 including the step of providing the first transmission antenna substantially identical to the second transmission antenna.

17. The method according to claim 15 including the step of providing the first reception antenna substantially identical to the second reception antenna.

REMARKS

The specification and abstract have been amended in accordance with U. S. practice and for improved readability and clarity. A substitute specification is attached together with a marked up version of the substitute specification showing changes made.

The Drawing Correction Letter amends the drawings in accordance with U. S. practice.

New claims are presented substantially based on PCT claims but drawn in accordance with U. S. practice. Also, additional claims have been added.

The new claims 11-13 substantially replacing the PCT claims have not been narrowed and were not made for patentability reasons.

An Information Disclosure Statement is enclosed.

Respectfully submitted,

(Reg. No. 27,841)

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S P E C I F I C A T I O N

TITLE

"ANTENNA ARRAY FOR A RADIO STATION WHICH CAN BE OPERATED IN A PLURALITY OF FREQUENCY RANGES, AND A RADIO STATION"

BACKGROUND OF THE INVENTION

The invention relates to an antenna array for a radio station which can be operated in a plurality of frequency ranges, and a radio station, in particular a multiband mobile station.

National regulatory authorities divide a frequency range (around 900 MHz) provided for a radio system or mobile radio system, for example the GSM 900 (Global System for Mobile Communication) system, into different frequency bands, which are then allocated to different network operators, for example D1, D2. A different frequency range (around 1800 MHz) is allocated to a different mobile radio system, the DCS 1800 (Digital Communication System). Further different frequency ranges are allocated to further, if necessary, future mobile radio systems, such as the UMTS (Universal Mobile Telephony System) which is currently being standardized. In the case of a duplex system involving FDD (Frequency Division Duplex) systems such as the GSM system, different frequency bands can be provided for the uplink (mobile station to base station) than for the downlink (base station to mobile station). The duplex spacing is 45 MHz for the GSM 900 system and 95 MHz for the DCS 1800 system.

Terms and examples used in this application also often relate to a GSM mobile radio system. However, they are in no way restricted thereto; but with reference to the description, can also be easily

mapped by a person skilled in the art onto other, if necessary, future mobile radio systems such as CDMA systems, in particular wideband CDMA systems or TD/CDMA systems.

Mobile stations are known which, under the name of dual-band mobile stations or multiband radio stations, can be operated in a plurality of these frequency ranges and enable alternative communication via a plurality of these aforementioned mobile radio systems.

Figure 8 shows a schematic representation of a transceiver system of conventional mobile stations of this type. According to the different frequency ranges of the GSM system and the DCS system in which the mobile station can be operated, different power amplifiers GSM PA, DCS PA are provided whose transmission signals are fed via an antenna switch S and a diplexer D, which essentially comprises a filter or duplexer, and an antenna ANT, such as a rod antenna. In the opposite direction, reception signals are received by the antenna ANT and are fed via the diplexer D and the antenna switch S to the reception amplifiers (low noise amplifiers) GSM LNA, DCS LNA corresponding to the different frequency ranges of the different mobile radio systems. An antenna switch S and a diplexer D (or a duplexer) are contained in the antenna array or are assigned to the antenna.

However, there has recently been an increasing requirement in radio stations, particularly in mobile stations for increasingly smaller, more compact and lighter devices.

SUMMARY OF THE INVENTION

An object of the invention is to indicate an antenna array for a radio station which can be operated in a plurality of frequency ranges and which enables implementation of small, lightweight radio stations, in particular mobile stations.

A mobile station for operation within different mobile radio systems to which a different frequency range is in each case allocated. Each frequency range in each case has a transmission frequency band and a reception frequency band. A first transmission antenna is provided for transmitting signals within the transmission frequency band of the first frequency range. A second transmission antenna is provided for transmitting signals within the transmission frequency band of the second frequency range. The first reception antenna is provided for receiving signals within the reception frequency band of the first frequency range. A second reception antenna is provided for receiving signals within the reception frequency band of the second frequency range.

In a method of the invention, a mobile station is operated within different mobile radio systems to which a different frequency range is in each case allocated. Each frequency range in each case has a transmission frequency band and a reception frequency band. Signals are transmitted within the transmission frequency band of a first frequency range with a first transmission antenna. Signals are transmitted within the transmission frequency band of a second frequency range with a second transmission antenna. Signals are received within a reception frequency band of the first frequency range with a first reception antenna.

Signals are received within a reception frequency band of the second frequency range with a second reception antenna.

The invention is therefore based, among other concepts, on the idea of using a plurality of antennas, whereby different antennas are provided for transmission signals and reception signals.

As a result, antenna switches are no longer required and therefore a small, lightweight antenna array is implemented for a radio station which is operated in a plurality of frequency ranges.

In a further design, different antennas are also provided for different frequency ranges.

As a result, a diplexer or duplexer can also be dispensed with and an even smaller, more lightweight antenna array can therefore be implemented.

In a further embodiment of the invention, the polarization direction of an antenna for transmission signals differs from the polarization direction of an antenna for reception signals.

The excitation of a reception antenna by a corresponding transmission antenna fitted in the same radio station can thus be prevented.

The invention is described in detail below with reference to preferred embodiments, which are explained by means of the figures listed below.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of an antenna array with different antennas for transmission signals and reception signals;

Figure 2 is a block diagram of an antenna array with different antennas for different frequency ranges, transmission signals and reception signals;

Figure 3 is a block diagram of an antenna array with different antennas for transmission signals and reception signals, and for reception signals of different frequency ranges;

Figure 4 is a block diagram of an antenna array with different antennas for transmission signals and reception signals, and for transmission signals of different frequency ranges;

Figure 5 is a cross-sectional view of a patch antenna;

Figure 6 is an antenna array with different polarization directions for transmission signals and reception signals;

Figure 7 is a block diagram of a radio station; and

Figure 8 is a block diagram of a conventional antenna array.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the preferred embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Figure 1 shows a block diagram of an antenna array A, in which different antennas ANT are provided for the transmission mode and the reception mode. In order to show the embodiments clearly, the block

diagrams of the antenna arrays are substantially simplified and therefore show no passive components, such as filters, 50-ohm adapter circuits, or power-regulating loops of the amplifiers. The transmission and reception amplifiers can also be regarded as representing the transmission and reception paths.

In the context of this application, an "antenna" also contains a resonator and a connection assigned to this resonator.

GSM and DCS transmission signals are amplified by a GSM DCS power amplifier GSM DCS PA and are fed and emitted via a connection of the associated antenna ANT1 which is adapted to the transmission frequency band of the GSM 900 frequency range and to the transmission frequency band of the DCS 1800 frequency range.

GSM and DCS reception signals are received by a second antenna ANT2 which is adapted to the reception frequency band of the DCS 1800 frequency range and to the reception frequency band of the GSM 900 frequency range. Following corresponding filtering by a diplexer, the signals are amplified by corresponding reception amplifiers DCS LNA (low noise amplifiers) GSM LNA. It is thus possible to dispense with antenna switches and thereby implement a small, lightweight antenna array.

Figure 2 shows a block diagram of an antenna array A, in which different antennas ANT are provided for different frequency bands and different antennas are likewise provided for the transmission mode and the reception mode.

GSM transmission signals are amplified by a GSM power amplifier GSM PA and are fed via a connection of the associated antenna ANT1 which is adapted to the

transmission frequency band of the GSM 900 frequency range. DCS transmission signals are amplified by a corresponding different power amplifier DCS PA and are fed to a second antenna ANT2 which is adapted to the transmission frequency band of the DCS 1800 frequency range and is emitted there.

DCS reception signals are received by a third antenna ANT3 which is adapted to the reception frequency band of the DCS 1800 frequency range, are amplified by a corresponding reception amplifier DCS LNA (low noise amplifier) and, following demodulation and filtering, are fed to a digital signal processor of a radio station. GSM reception signals are received by a fourth correspondingly adapted antenna ANT4 and are amplified by a corresponding reception amplifier device GSM LNA. It is thus possible to dispense with antenna switches and diplexers and thereby implement a small, lightweight antenna array.

In designs of the invention, further antennas are provided which are either likewise used to implement frequency duplex operation, albeit in a different frequency range, or to implement time duplex operation in a different frequency range, to which antenna switches or diplexers can be assigned for signal separation. Examples of further frequency ranges are the frequency ranges of third-generation mobile radio systems such as the UMTS system which is currently being standardized (combination of wideband CDMA and TD/CDMA), or other CDMA systems, the DECT system, or other cordless systems.

Figure 3 shows an embodiment which differs from the design shown in Figure 1 in that different antennas ANT2, ANT3 are provided for the reception signals

according to the different frequency ranges, thereby eliminating the need for a diplexer.

Figure 4 shows an embodiment which differs from the design shown in Figure 1 in that different transmission amplifiers GSM PA, DCS PA and different antennas are provided according to the different frequency ranges.

Figure 5 shows a section view of a patch antenna comprising a connection ANK, a ground area M, an insulation, for example ceramic, a substrate SUB, a resonator RES and a short circuit K between the resonator RES and the ground area M. The polarization direction POL of a patch antenna of this type is indicated by the double arrow. The signals can also be connected in a different manner to that shown here, for example capacitively.

Figure 6 shows an antenna array comprising four antennas which correspond to a transmission mode and a reception mode in two frequency ranges and which are arranged on a support, for example a board or substrate SUB, with corresponding connections ANK1-4, resonators RES1-4, and short circuits K1-4 between the ground area and the resonators.

In order as far as possible to prevent the excitation of a reception antenna by the corresponding transmission antenna in the same frequency range, the polarization directions of the corresponding transmission and reception antennas are aligned at right angles to one another.

In a different design of the invention, the different antennas are physically separated and are implemented with the maximum possible spacing between

them. This can also result in prevention of the aforementioned undesirable excitations.

In a different embodiment, all or at least some of the antennas are aligned in parallel with one another.

In a further embodiment of the invention, the individual antennas or resonators are narrowband antennas or resonators. This can also result in prevention of the aforementioned undesirable excitations.

Figure 7 shows a radio station which may, in particular, be a mobile station MS, comprising an operating unit MMI, a control device STE, a processing device VE, a power supply device SVE, a reception device EE, and a transmission device SE.

The control device STE essentially comprises a program-controlled microcontroller, which controls and monitors all essential elements and functions of the radio station.

The processing device VE can also be formed by a digital signal processor DSP.

The radio-frequency component HF comprises the transmission device SE, with a modulator and an amplifier, and a reception device EE with a demodulator and likewise an amplifier.

The frequency of a voltage-controlled oscillator VCO is fed via the synthesizer SYN to the transmission device SE and the reception device EE. The system clock for timing the processor devices of the equipment can also be generated by means of the voltage-controlled oscillator VCO. Reception signals are received and transmission signals are transmitted via the antenna array A, as shown in Figure 1.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirt of the invention are desired to be protected

ABSTRACT OF THE DISCLOSURE

An antenna array for a radio station which can be operated in a plurality of frequency ranges has a plurality of antennas, with different antennas being provided for transmission signals and reception signals.

[Description] S P E C I F I C A T I O N

[Antenna array for a radio station which can be operated in a plurality of frequency ranges, and a radio station] TITLE

"ANTENNA ARRAY FOR A RADIO STATION WHICH CAN BE OPERATED IN A PLURALITY OF FREQUENCY RANGES, AND A RADIO STATION"

BACKGROUND OF THE INVENTION

The invention relates to an antenna array for a radio station which can be operated in a plurality of frequency ranges, and a radio station, in particular a multiband mobile station.

National regulatory authorities divide a frequency range (around 900 MHz) provided for a radio system or mobile radio system, for example the GSM 900 (Global System for Mobile Communication) system, into different frequency bands, which are then allocated to different network operators, for example D1, D2. A different frequency range (around 1800 MHz) is allocated to a different mobile radio system, the DCS 1800 (Digital Communication System). Further different frequency ranges are allocated to further, if necessary, future mobile radio systems, such as the UMTS (Universal Mobile Telephony System) which is currently being standardized. In the case of a duplex system involving FDD (Frequency Division Duplex) systems such as the GSM system, different frequency bands can be provided for the uplink (mobile station to base station) than for the downlink (base station to mobile station). The duplex spacing is 45 MHz for the GSM 900 system and 95 MHz for the DCS 1800 system.

Terms and examples used in this application also often relate to a GSM mobile radio system [also;

however]. However, they are in no way restricted thereto[,]; but[,] with reference to the description, can also be easily mapped by [the] a person skilled in the art onto other, if necessary, future mobile radio systems such as CDMA systems, in particular wideband CDMA systems or TD/CDMA systems.

Mobile stations are known which, under the name of dual-band mobile stations or multiband radio stations, can be operated in a plurality of these frequency ranges and enable alternative communication via a plurality of these aforementioned mobile radio systems.

Figure 8 shows a schematic representation of a transceiver system of conventional mobile stations of this type. According to the different frequency ranges of the GSM system and the DCS system in which the mobile station can be operated, different power amplifiers GSM PA, DCS PA are provided whose transmission signals are fed via an antenna switch S and a diplexer D, which essentially comprises a filter[,] or duplexer, and an antenna ANT, such as a rod antenna. In the opposite direction, reception signals are received by the antenna ANT and [the] are fed via the diplexer D and the antenna switch S to the reception amplifiers (low noise amplifiers) GSM LNA, DCS LNA corresponding to the different frequency ranges of the different mobile radio systems. An antenna switch S and a diplexer D [or duplexer](or a duplexer) are contained in the antenna array or are assigned to the antenna.

However, there has recently been an increasing requirement in radio stations, particularly in mobile stations for increasingly smaller, more compact and lighter devices.

SUMMARY OF THE INVENTION

An [The] object of the invention is [therefore] to indicate an antenna array for a radio station which can be operated in a plurality of frequency ranges and which enables implementation of small, lightweight radio stations, in particular mobile stations.

A mobile station for operation within different mobile radio systems to which a different frequency range is in each case allocated. Each frequency range in each case has a transmission frequency band and a reception frequency band. A first transmission antenna is provided for transmitting signals within the transmission frequency band of the first frequency range. A second transmission antenna is provided for transmitting signals within the transmission frequency band of the second frequency range. The first reception antenna is provided for receiving signals within the reception frequency band of the first frequency range. A second reception antenna is provided for receiving signals within the reception frequency band of the second frequency range.

In a method of the invention, a mobile station is operated within different mobile radio systems to which a different frequency range is in each case allocated. Each frequency range in each case has a transmission frequency band and a reception frequency band. Signals are transmitted within the transmission frequency band of a first frequency range with a first transmission antenna. Signals are transmitted within the transmission frequency band of a second frequency range with a second transmission antenna. Signals are received within a reception frequency band of the first frequency range with a first reception antenna.

Signals are received within a reception frequency band of the second frequency range with a second reception antenna [This object is achieved by the features of the independent claims. Further designs are presented in the subclaims].

The invention is therefore based, among other concepts, on the idea of using a plurality of antennas, whereby different antennas are provided for transmission signals and reception signals.

As a result, antenna switches are no longer required and therefore a small, lightweight antenna array [can be] is implemented for a radio station which [can be] is operated in a plurality of frequency ranges.

In a further design, different antennas are also provided for different frequency ranges.

As a result, a diplexer or duplexer can also be dispensed with and an even smaller, more lightweight antenna array can therefore be implemented.

In a further embodiment of the invention, the polarization direction of an antenna for transmission signals differs from the polarization direction of an antenna for reception signals.

The excitation of a reception antenna by a corresponding transmission antenna fitted in the same radio station can thus be prevented.

The invention is described in detail below with reference to preferred embodiments, which are explained by means of the figures listed below[:].

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a block diagram of an antenna array with different antennas for transmission signals and reception signals;

Figure 2 is a block diagram of an antenna array with different antennas for different frequency ranges, transmission signals and reception signals;

Figure 3 is a block diagram of an antenna array with different antennas for transmission signals and reception signals, and for reception signals of different frequency ranges;

Figure 4 is a block diagram of an antenna array with different antennas for transmission signals and reception signals, and for transmission signals of different frequency ranges;

Figure 5 is a cross [section]-sectional view of a patch antenna;

Figure 6 is an antenna array with different polarization directions for transmission signals and reception signals;

Figure 7 is a block diagram of a radio station; and

Figure 8 is a block diagram of a conventional antenna array.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For the purposes of promoting an understanding of the principles of the invention, reference will now be made to the preferred embodiment illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended, such alterations and further modifications in the illustrated device, and such further applications of the principles of the invention as illustrated therein being contemplated as would normally occur to one skilled in the art to which the invention relates.

Figure 1 shows a block diagram of an antenna array A, in which different antennas ANT are provided for the transmission mode and the reception mode. In order to show the embodiments clearly, the block diagrams of the antenna arrays are substantially simplified and therefore show no passive components, such as filters, 50-ohm adapter circuits, or power-regulating loops of the amplifiers. The transmission and reception amplifiers can also be regarded as representing the transmission and reception paths.

In the context of this application, an "antenna" also contains a resonator and a connection assigned to this resonator.

GSM and DCS transmission signals are amplified by a GSM DCS power amplifier GSM DCS PA and are fed and emitted via a connection of the associated antenna ANT1 which is adapted to the transmission frequency band of the GSM 900 frequency range and to the transmission frequency band of the DCS 1800 frequency range.

GSM and DCS reception signals are received by a second antenna ANT2 which is adapted to the reception frequency band of the DCS 1800 frequency range and to the reception frequency band of the GSM 900 frequency range [and, following]. Following corresponding filtering by a diplexer, the signals are amplified by corresponding reception amplifiers DCS LNA (low noise amplifiers) GSM LNA. It is thus possible to dispense with antenna switches and thereby implement a small, lightweight antenna array.

Figure 2 shows a block diagram of an antenna array A, in which different antennas ANT are provided for different frequency bands and different antennas

are likewise provided for the transmission mode and the reception mode.

GSM transmission signals are amplified by a GSM power amplifier GSM PA and are fed via a connection of the associated antenna ANT1 which is adapted to the transmission frequency band of the GSM 900 frequency range. DCS transmission signals are amplified by a corresponding different power amplifier DCS PA and are fed to a second antenna ANT2 which is adapted to the transmission frequency band of the DCS 1800 frequency range and is emitted there.

DCS reception signals are received by a third antenna ANT3 which is adapted to the reception frequency band of the DCS 1800 frequency range, are amplified by a corresponding reception amplifier DCS LNA (low noise amplifier) and, following demodulation and filtering, are fed to a digital signal processor of a radio station. GSM reception signals are received by a fourth correspondingly adapted antenna ANT4 and are amplified by a corresponding reception amplifier device GSM LNA. It is thus possible to dispense with antenna switches and diplexers and thereby implement a small, lightweight antenna array.

In designs of the invention, further antennas are provided which are either likewise used to implement frequency duplex operation, albeit in a different frequency range, or to implement time duplex operation in a different frequency range, to which antenna switches or diplexers can be assigned for signal separation. Examples of further frequency ranges are the frequency ranges of third-generation mobile radio systems such as the UMTS system which is currently being standardized (combination of wideband

CDMA and TD/CDMA), or other CDMA systems [or], the DECT system, or other cordless systems.

Figure 3 shows an embodiment which differs from the design shown in Figure 1 in that different antennas ANT2, ANT3 are provided for the reception signals according to the different frequency ranges, thereby eliminating the need for a diplexer.

Figure 4 shows an embodiment which differs from the design shown in Figure 1 in that different transmission amplifiers GSM PA, DCS PA and different antennas are provided according to the different frequency ranges.

Figure 5 shows a section view of a patch antenna comprising a connection ANK, a ground area M, an [insulating] insulation, for example ceramic, a substrate SUB, a resonator RES and a short circuit K between the resonator RES and the ground area M. The polarization direction POL of a patch antenna of this type is indicated by the double arrow. The signals can also be connected in a different manner to that shown here, for example capacitively.

Figure 6 shows an antenna array comprising four antennas which correspond to a transmission mode and a reception mode in two frequency ranges and which are arranged on a support, for example a board or substrate SUB, with corresponding connections ANK1-4, resonators RES1-4, and short circuits K1-4 between the ground area and the resonators.

In order as far as possible to prevent the excitation of a reception antenna by the corresponding transmission antenna in the same frequency range, the polarization directions of the corresponding transmission and reception antennas are aligned at right angles to one another.

In a different design of the invention, the different antennas are physically separated and are implemented with the maximum possible spacing between them. This can also result in prevention of the aforementioned undesirable excitations.

In a different embodiment, all or at least some of the antennas are aligned in parallel with one another.

In a further embodiment of the invention, the individual antennas or resonators are narrowband antennas or resonators. This can also result in prevention of the aforementioned undesirable excitations.

Figure 7 shows a radio station which may, in particular, be a mobile station MS, comprising an operating unit MMI, a control device STE, a processing device VE, a power supply device SVE, a reception device EE, and a transmission device SE.

The control device STE essentially comprises a program-controlled microcontroller, which controls and monitors all essential elements and functions of the radio station.

The processing device VE can also be formed by a digital signal processor DSP.

The radio-frequency component HF comprises the transmission device SE, with a modulator and an amplifier, and a reception device EE with a demodulator and likewise an amplifier.

The frequency of a voltage-controlled oscillator VCO is fed via the synthesizer SYN to the transmission device SE and the reception device EE. The system clock for timing the processor devices of the equipment can also be generated by means of the voltage-controlled oscillator VCO. Reception signals

are received and transmission signals are transmitted via the antenna array A, as shown in Figure 1.

While the invention has been illustrated and described in detail in the drawings and foregoing description, the same is to be considered as illustrative and not restrictive in character, it being understood that only the preferred embodiment has been shown and described and that all changes and modifications that come within the spirt of the invention are desired to be protected.

[Abstract] [Antenna array for a radio station which can be operated in a plurality of frequency ranges, and a radio station]

ABSTRACT OF THE DISCLOSURE

An antenna array for a radio station which can be operated in a plurality of frequency ranges has a plurality of antennas, with different antennas being provided for transmission signals and reception signals.

[Figure 1]

Description

Antenna array for a radio station which can be operated in a plurality of frequency ranges, and a radio station

The invention relates to an antenna array for a radio station which can be operated in a plurality of frequency ranges, and a radio station, in particular a multiband mobile station.

National regulatory authorities divide a frequency range (around 900 MHz) provided for a radio system or mobile radio system, for example the GSM 900 (Global System for Mobile Communication) system, into different frequency bands, which are then allocated to different network operators, for example D1, D2. A different frequency range (around 1800 MHz) is allocated to a different mobile radio system, the DCS 1800 (Digital Communication System). Further different frequency ranges are allocated to further, if necessary, future mobile radio systems, such as the UMTS (Universal Mobile Telephony System) which is currently being standardized. In the case of a duplex system involving FDD (Frequency Division Duplex) systems such as the GSM system, different frequency bands can be provided for the uplink (mobile station to base station) than for the downlink (base station to mobile station). The duplex spacing is 45 MHz for the GSM 900 system and 95 MHz for the DCS 1800 system.

Terms and examples used in this application also often relate to a GSM mobile radio system also; however, they are in no way restricted thereto, but, with reference to the description, can also be easily mapped by the person skilled in the art onto other, if necessary, future mobile radio systems such as CDMA systems, in particular wideband CDMA systems or TD/CDMA systems.

Mobile stations are known which, under the name of dual-band mobile stations or multiband radio stations, can be operated in a plurality of these frequency ranges and enable alternative communication via a plurality of these aforementioned mobile radio systems.

Figure 8 shows a schematic representation of a transceiver system of conventional mobile stations of this type. According to the different frequency ranges of the GSM system and the DCS system in which the mobile station can be operated, different power amplifiers GSM PA, DCS PA are provided whose transmission signals are fed via an antenna switch S and a diplexer D, which essentially comprises a filter, or duplexer, an antenna ANT, such as a rod antenna. In the opposite direction, reception signals are received by the antenna ANT and the fed via the diplexer D and the antenna switch S to the reception amplifiers (low noise amplifiers) GSM LNA, DCS LNA corresponding to the different frequency ranges of the different mobile radio systems. An antenna switch S and a diplexer D or duplexer are contained in the antenna array or are assigned to the antenna.

However, there has recently been an increasing requirement in radio stations, particularly in mobile stations for increasingly smaller, more compact and lighter devices.

The object of the invention is therefore to indicate an antenna array for a radio station which can be operated in a plurality of frequency ranges and which enables implementation of small, lightweight radio stations, in particular mobile stations.

This object is achieved by the features of the independent claims. Further designs are presented in the subclaims.

The invention is therefore based on the idea of using a plurality of antennas, whereby different antennas are provided for transmission signals and reception signals.

As a result, antenna switches are no longer required and therefore a small, lightweight antenna array can be implemented for a radio station which can be operated in a plurality of frequency ranges.

In a further design, different antennas are also provided for different frequency ranges.

As a result, a diplexer or duplexer can also be dispensed with and an even smaller, more lightweight antenna array can therefore be implemented.

In a further embodiment of the invention, the polarization direction of an antenna for transmission signals differs from the polarization direction of an antenna for reception signals.

The excitation of a reception antenna by a corresponding transmission antenna fitted in the same radio station can thus be prevented.

The invention is described in detail below with reference to preferred embodiments, which are explained by means of the figures listed below:

Figure 1 is a block diagram of an antenna array with different antennas for transmission signals and reception signals;

Figure 2 is a block diagram of an antenna array with different antennas for different frequency ranges, transmission signals and reception signals;

Figure 3 is a block diagram of an antenna array with different antennas for transmission signals and reception signals and for reception signals of different frequency ranges;

Figure 4 is a block diagram of an antenna array with different antennas for transmission signals and reception signals and for transmission signals of different frequency ranges;

Figure 5 is a cross section of a patch antenna;

Figure 6 is an antenna array with different polarization directions for transmission signals and reception signals;

Figure 7 is a block diagram of a radio station;

Figure 8 is a block diagram of a conventional antenna array.

Figure 1 shows a block diagram of an antenna array A, in which different antennas ANT are provided for transmission mode and reception mode. In order to show the embodiments clearly, the block diagrams of the antenna arrays are substantially simplified and therefore show no passive components, such as filters, 50-ohm adapter circuits, or power-regulating loops of the amplifiers. The transmission and reception amplifiers can also be regarded as representing the transmission and reception paths.

In the context of this application, an "antenna" also contains a resonator and a connection assigned to this resonator.

GSM and DCS transmission signals are amplified by a GSM DCS power amplifier GSM DCS PA and are fed and emitted via a connection of the associated antenna ANT1 which is adapted to the transmission frequency band of the GSM 900 frequency range and to the transmission frequency band of the DCS 1800

frequency range.

GSM and DCS reception signals are received by a second antenna ANT2 which is adapted to the reception frequency band of the DCS 1800 frequency range and to the reception frequency band of the GSM 900 frequency range and, following corresponding filtering by a diplexer, are amplified by corresponding reception amplifiers DCS LNA (low noise amplifiers) GSM LNA. It is thus possible to dispense with antenna switches and thereby implement a small, lightweight antenna array.

Figure 2 shows a block diagram of an antenna array A, in which different antennas ANT are provided for different frequency bands and different antennas are likewise provided for transmission mode and reception mode.

GSM transmission signals are amplified by a GSM power amplifier GSM PA and fed via a connection of the associated antenna ANT1 which is adapted to the transmission frequency band of the GSM 900 frequency range. DCS transmission signals are amplified by a corresponding different power amplifier DCS PA and fed to a second antenna ANT2 which is adapted to the transmission frequency band of the DCS 1800 frequency range and emitted.

DCS reception signals are received by a third antenna ANT3 which is adapted to the reception frequency band of the DCS 1800 frequency range, are amplified by a corresponding reception amplifier DCS LNA (low noise amplifier) and, following demodulation and filtering, are fed to a digital signal processor of a radio station. GSM reception signals are received by a fourth correspondingly adapted antenna ANT4 and are amplified by a corresponding reception amplifier device GSM LNA. It is thus possible to dispense with antenna switches and diplexers and thereby implement a small, lightweight antenna array.

In designs of the invention, further antennas are provided which are either likewise used to implement frequency duplex operation, albeit in a different frequency range, or to implement time duplex operation in a different frequency range, to which antenna switches or diplexers can be assigned for signal separation. Examples of further frequency ranges are the frequency ranges of third-generation mobile radio systems such as the UMTS system which is currently being standardized (combination of wideband CDMA and TD/CDMA), or other CDMA systems or the DECT system or other cordless systems.

Figure 3 shows an embodiment which differs from the design shown in Figure 1 in that different antennas ANT2, ANT3 are provided for the reception signals according to the different frequency ranges, thereby eliminating the need for a diplexer.

Figure 4 shows an embodiment which differs from the design shown in Figure 1 in that different transmission amplifiers GSM PA, DCS PA and different antennas are provided according to the different frequency ranges.

Figure 5 shows a section view of a patch antenna comprising a connection ANK, a ground area M, an insulating, for example ceramic, substrate SUB, a resonator RES and a short circuit K between the resonator RES and the ground area M. The polarization direction POL of a patch antenna of this type is indicated by the double arrow. The signals can also be connected in a different manner to that shown here, for example capacitively.

Figure 6 shows an antenna array comprising four antennas which correspond to a transmission mode and a reception mode in two frequency ranges and which are arranged on a support, for example a board or substrate SUB, with corresponding connections ANK1-4, resonators RES1-4 and short circuits K1-4 between the ground area and the resonators.

In order as far as possible to prevent the excitation of a reception antenna by the corresponding transmission antenna in the same frequency range, the polarization directions of the corresponding transmission and reception antennas are aligned at right angles to one another.

In a different design of the invention, the different antennas are physically separated and are implemented with the maximum possible spacing between them. This can also result in prevention of the aforementioned undesirable excitations.

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In a further embodiment of the invention, the individual antennas or resonators are narrowband antennas or resonators. This can also result in prevention of the aforementioned undesirable excitations.

Figure 7 shows a radio station which may, in particular, be a mobile station MS, comprising an operating unit MMI, a control device STE, a processing device VE, a power supply device SVE, a reception device EE and a transmission device SE.

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The frequency of a voltage-controlled oscillator VCO is fed via the synthesizer SYN to the transmission device SE and the reception device EE. The system clock for timing the processor devices of the equipment can also be generated by means of the voltage-controlled oscillator VCO. Reception signals are received and transmission signals are transmitted via the antenna array A, as shown in Figure 1.

Claims

1. A mobile station for operation within different mobile radio systems, to which a different frequency range is in each case allocated, each frequency range in each case having a transmission frequency band and a reception frequency band, with

- a first transmission antenna for transmitting signals within the transmission frequency band of a first frequency range,

- a second transmission antenna for transmitting signals within the transmission frequency band of a second frequency range,

- a first reception antenna for receiving signals within the reception frequency band of the first frequency range, and

- a second reception antenna for receiving signals within the reception frequency band of the second frequency range.

2. The mobile station as claimed in claim 1, in which

- the first transmission antenna is identical to the second transmission antenna.

3. The mobile station as claimed in one of claims 1 or 2, in which the first reception antenna is identical to the second reception antenna.

Abstract

Antenna array for a radio station which can be operated in a plurality of frequency ranges, and a radio station

An antenna array for a radio station which can be operated in a plurality of frequency ranges has a plurality of antennas, different antennas being provided for transmission signals and reception signals.

Figure 1

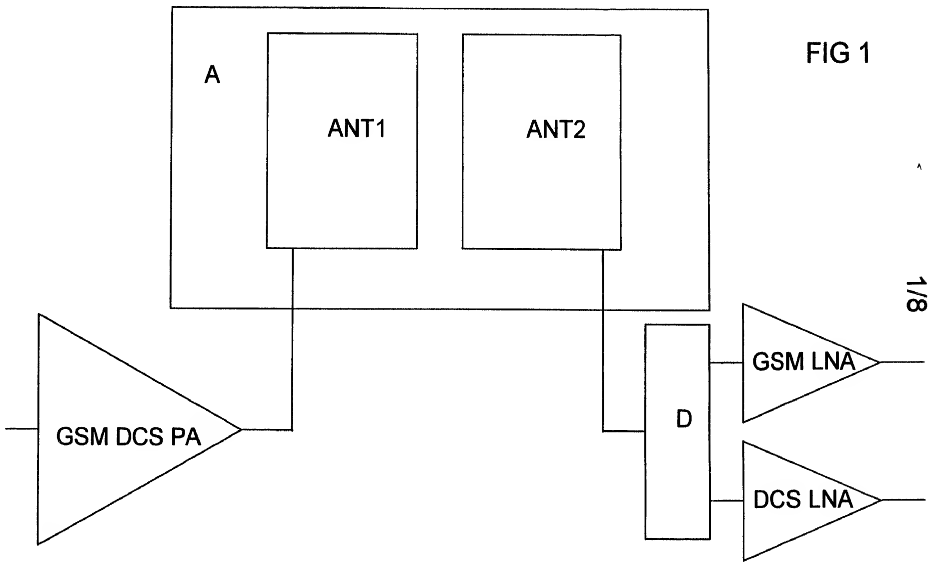


FIG 1

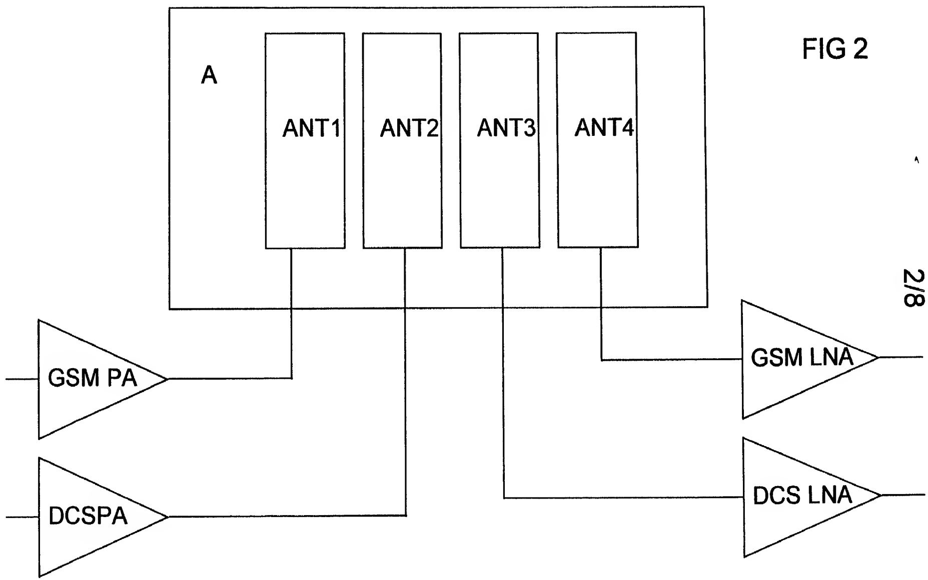


FIG 2

FIG 3

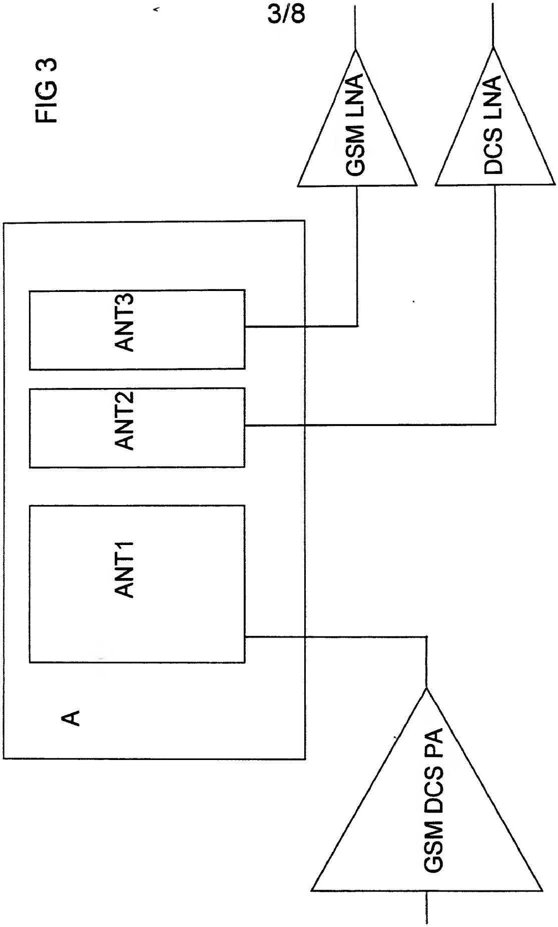


FIG 4

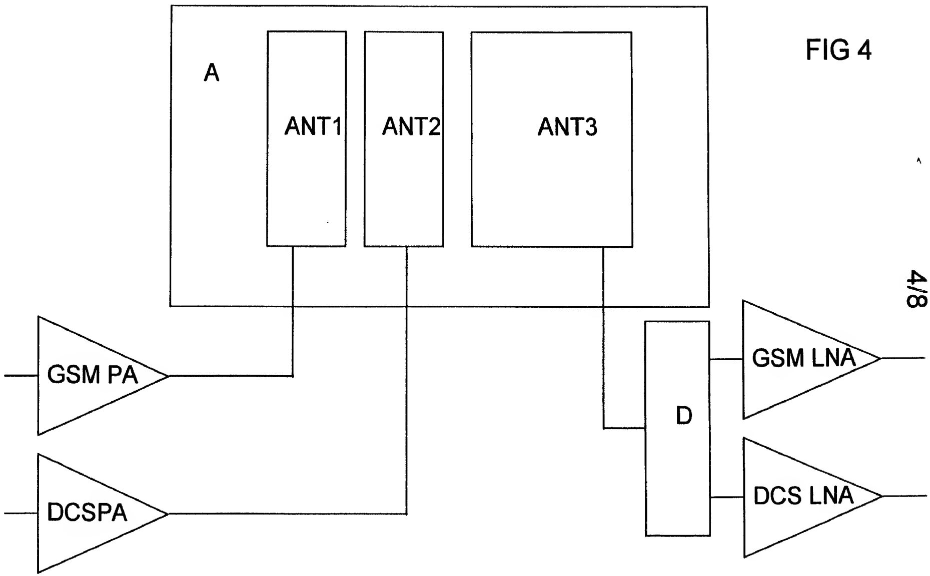


FIG 5

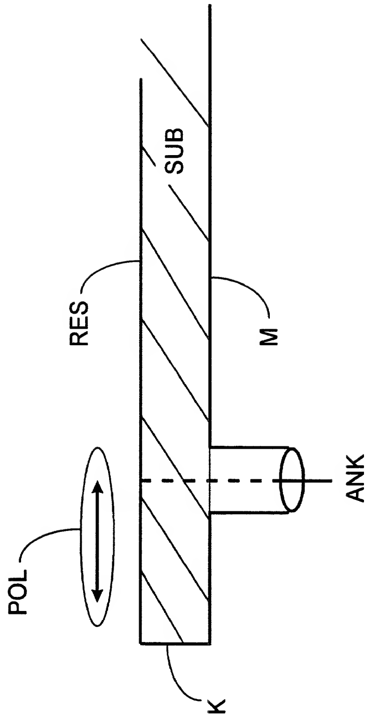


FIG 7

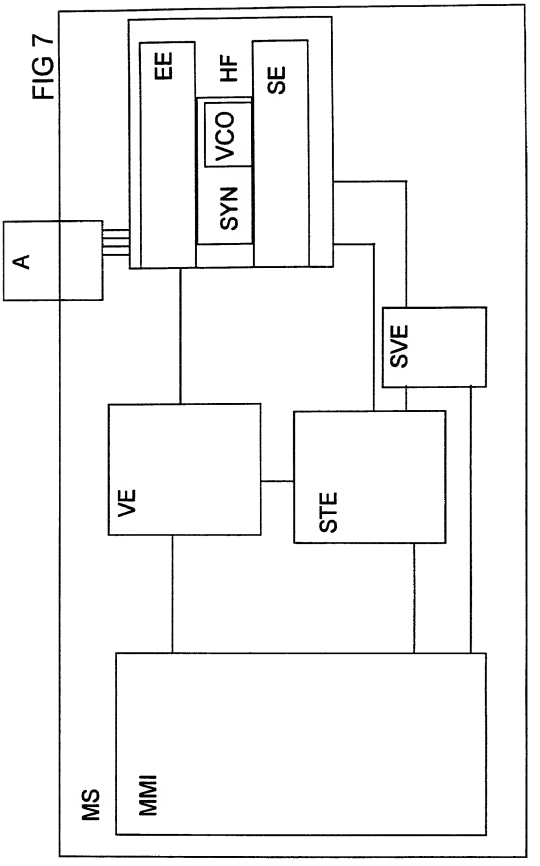
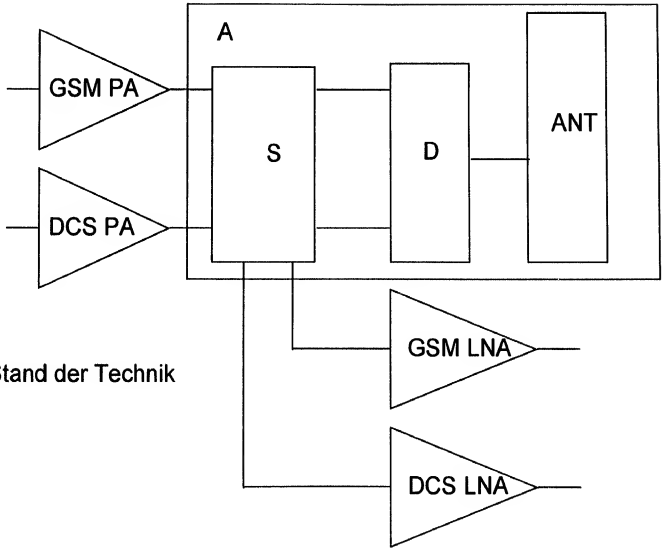


FIG 8



Stand der Technik

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Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

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My residence, post office address and citizenship are as stated below next to my name,

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I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Antennenanordnung für eine in mehreren Frequenzbereichen betreibbare Funkstation und Funkstation

deren Beschreibung

the specification of which

(zutreffendes ankreuzen)

(check one)

☐ hier beigefügt ist.

☐ is attached hereto.

☒ am 01. Oktober 1999 als PCT internationale Anmeldung PCT Anmeldungsnummer PCT/DE99/03170 eingereicht wurde und am _____ abgeändert wurde (falls tatsächlich abgeändert).

☐ was filed on _____ as PCT international application PCT Application No. _____ and was amended on _____ (if applicable)

Ich bestätige hiermit, dass ich den Inhalt der obigen Patentanmeldung einschliesslich der Ansprüche durchgesehen und verstanden habe, die eventuell durch einen Zusatzantrag wie oben erwähnt abgeändert wurde.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

Ich erkenne meine Pflicht zur Offenbarung irgendwelcher Informationen, die für die Prüfung der vorliegenden Anmeldung in Einklang mit Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) von Wichtigkeit sind, an.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

Ich beanspruche hiermit ausländische Prioritätsvorteile gemäss Abschnitt 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 119 aller unten angegebenen Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde, und habe auch alle Auslandsanmeldungen für ein Patent oder eine Erfindersurkunde nachstehend gekennzeichnet, die ein Anmeldedatum haben, das vor dem Anmeldedatum der Anmeldung liegt, für die Priorität beansprucht wird.

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Erklärung Für Patentanmeldungen Mit Vollmacht
German Language Declaration

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deren Beschreibung

the specification of which

(zutreffendes ankreuzen)

(check one)

☒ hier beigefügt ist.

☒ is attached hereto.

☐ am _____ als PCT internationale Anmeldung PCT Anmeldungsnummer _____ eingereicht wurde und am _____ abgeändert wurde (falls tatsächlich abgeändert).

☐ was filed on _____ as PCT international application PCT Application No. _____ and was amended on _____ (if applicable)

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Form PTO-FB-240 (8-83)
Patent and Trademark Office-U.S. DEPARTMENT OF COMMERCE

German Language Declaration

Prior foreign appplications
Priorität beansprucht

			Priority Claimed	
198 47 660.4	Germany	15. Oktober 1998	☒	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein
			☐	☐
(Number) (Nummer)	(Country) (Land)	(Day Month Year Filed) (Tag Monat Jahr eingereicht)	Yes Ja	No Nein

Ich beanspruche hiermit gemäss Absatz 35 der Zivilprozessordnung der Vereinigten Staaten, Paragraph 120, den Vorzug aller unten aufgeführten Anmeldungen und falls der Gegenstand aus jedem Anspruch dieser Anmeldung nicht in einer früheren amerikanischen Patentanmeldung laut dem ersten Paragraphen des Absatzes 35 der Zivilprozeßordnung der Vereinigten Staaten, Paragraph 122 offenbart ist, erkenne ich gemäss Absatz 37, Bundesgesetzbuch, Paragraph 1.56(a) meine Pflicht zur Offenbarung von Informationen an, die zwischen dem Anmeldedatum der früheren Anmeldung und dem nationalen oder PCT internationalen Anmeldedatum dieser Anmeldung bekannt geworden sind.

I hereby claim the benefit under Title 35. United States Code. §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §122, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occured between the filing date of the prior application and the national or PCT international filing date of this application.

(Application Serial No.) (Anmeldeseriennummer)	(Filing Date) (Anmeldedatum)	(Status) (patentiert, anhangig, aufgegeben)	(Status) (patented, pending, abandoned)
(Application Serial No.) (Anmeldeseriennummer)	(Filing Date) (Anmeldedatum)	(Status) (patentiert, anhängig, aufgeben)	(Status) (patented, pending, abandoned)

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German Language Declaration

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POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. *(list name and registration number)*

And I hereby appoint

Messrs. John D. Simpson (Registration No. 19,842) Lewis T. Steadman (17,074), William C. Stueber (16,453), P. Phillips Connor (19,259), Dennis A. Gross (24,410), Marvin Moody (16,549), Steven H. Noll (28,982), Brett A. Valiquet (27,841), Thomas I. Ross (29,275), Kevin W. Guynn (29,927), Edward A. Lehmann (22,312), James D. Hobart (24,149), Robert M. Barrett (30,142), James Van Santen (16,584), J. Arthur Gross (13,615), Richard J. Schwarz (13,472) and Melvin A. Robinson (31,870), David R. Metzger (32,919), John R. Garrett (27,888) all members of the firm of Hill, Steadman & Simpson, A Professional Corporation.

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Send Correspondence to:

HILL, STEADMAN & SIMPSON
A Professional Corporation
85th Floor Sears Tower, Chicago, Illinois 60606

Voller Name des einzigen oder ursprünglichen Erfinders:	Full name of sole or first inventor:
ECKERT, Rainer	
Unterschrift des Erfinders Datum: 10.02.01	Inventor's signature Date
Wohnsitz: D-81677 München, Germany DEX	Residence
Staatsangehörigkeit: Bundesrepublik Deutschland	Citizenship
Postanschrift: Zaubzerstr. 29 D-81677 München Bundesrepublik Deutschland	Post Office Address
Voller Name des zweiten Miterfinders (falls zutreffend):	Full name of second joint inventor, if any:
Unterschrift des Erfinders Datum	Second Inventor's signature Date
Wohnsitz	Residence
Staatsangehörigkeit	Citizenship
Postanschrift	Post Office Address

(Bitte entsprechende Informationen und Unterschriften im Falle von dritten und weiteren Miterfindern angeben).

(Supply similar information and signature for third and subsequent joint inventors).